Alberta

Scientific
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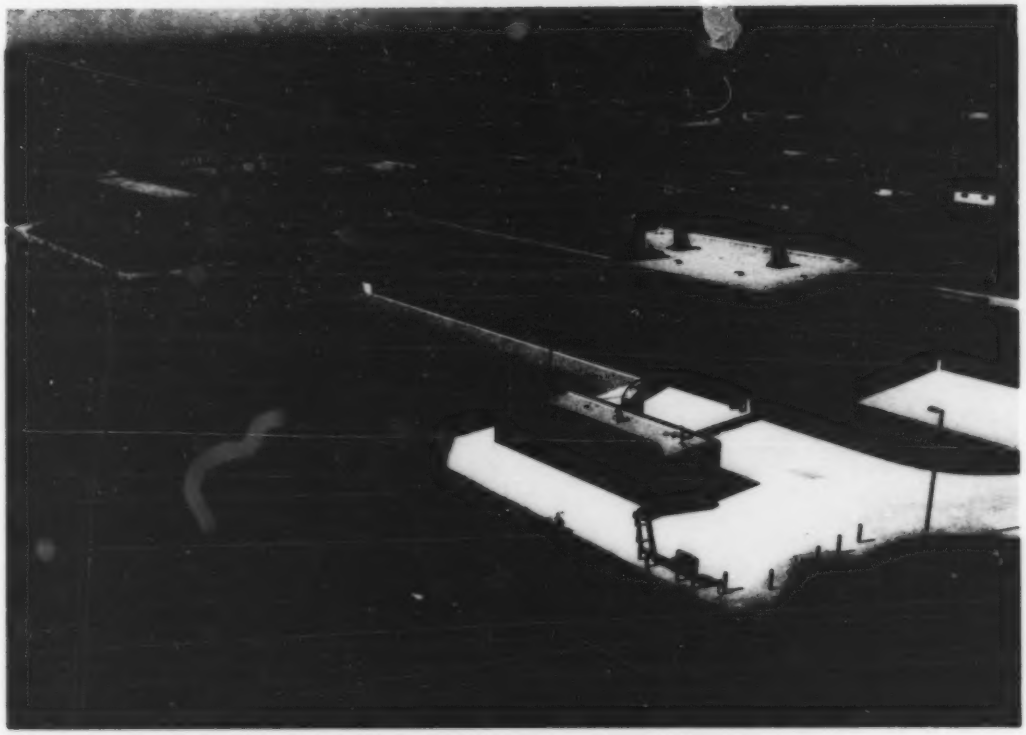
Services

Coal Research Centre, Devon

A project supported in part
by the Alberta/Canada
Energy Resources
Research Fund



ALBERTA
OFFICE OF
COAL

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Cover photo courtesy of Alberta Research Council.

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Foreword

Since 1976, numerous projects have been initiated in Alberta by industry and by academic research institutions which are aimed at better utilization of Alberta's energy resources.

These research, development and demonstration efforts were funded by the Alberta/Canada Energy Resources Research Fund (A/CERRF), which was established as a result of the 1974 agreement on oil prices between the federal government and the producing provinces.

Responsibility for applying and administering the fund rests with the A/CERRF Committee, made up of senior Alberta and federal government officials.

A/CERRF program priorities have focused on coal and conventional energy resources, as well as energy conservation and renewable energy. Program administration is provided by staff within the Scientific and Engineering Services and Research Division of Alberta Energy.

In recognition of the importance of coal to Alberta's economy, the Alberta Office of Coal Research and Technology was established in 1984 within Alberta Energy and Natural Resources (now Alberta Energy). Its primary purpose is to encourage the development and application of new technologies related to Alberta coals. The Office provides funding contributions to research and development projects in industry, academic institutions and other research establishments and monitors their progress in an overall program of improving the production, transportation and marketability of Alberta coals.

In order to make research results available to industry and others who can use the information, highlights of studies are reported in a series of technology transfer booklets. For more information about other publications in the series, please refer to page 10.

Coal Research Centre, Devon

In September 1985, Canada's most comprehensive coal research centre was officially opened in Devon, Alberta, 32 kilometres (20 miles) southwest of the City of Edmonton. The 16 032 m^2 (172 573 sq. ft.) facility was built with funds provided by the Alberta/Canada Energy Resources Research Fund (A/CERRF), and is appropriately located in the province that has at least 70 per cent of Canada's coal.

The principal centre for coal research in western Canada is occupied by three coal research agencies. They are: (1) the coal research laboratories of the Canada Centre for Mineral and Energy Technology (CANMET); (2) the Coal Mining Research Company; and (3) the Coal and Hydrocarbon Processing Department of the Alberta Research Council.

Each of these agencies is conducting separate but complementary investigations of lignite, subbituminous, bituminous thermal and bituminous coking coals in a co-ordinated manner, with the common goal of maintaining and augmenting the competitive position of western Canadian coals in domestic and international markets.

The combined capabilities represented by the 125 people who work at the Centre provide research experience in coal exploration, characterization, production, processing, conversion and utilization. This spectrum of work is broader than in any other Canadian coal research centre.

Facility Layout

The Centre is divided into four segments: (1) a Pilot Plant, (2) an Industrial Laboratory/Support area, (3) a High Head Laboratory, and (4) an Analytical Laboratory/Office wing.

The **Pilot Plant** accommodates all coal grinding, drying and upgrading equipment, as well as the receiving area for incoming shipments of coal. To minimize and control dust, the pilot plant is equipped with an elaborate ventilation and dust collection system, as well as wet gas scrubbers to remove noxious substances and particulates in gaseous emissions, and appropriately coded electrical fixtures. Some wall sections are hinged so they can swing open in case of an explosion. Also, for health and safety reasons, the pilot plant is located farthest from the clean areas of the Centre.

Adjacent to the pilot plant is the **Industrial Laboratory/Support** area. Here, industrial-type laboratories are used for bench-scale and continuous process development experiments that require coal samples weighing several kilograms. It also houses support services for the pilot plant, as well as workshops, equipment storage areas and central stores. An enclosed dust lock, or link, connects the industrial laboratories to the pilot plant. Change rooms have been designed into the link so that workers can replace their soiled clothing with clean clothing before they pass from the pilot plant to the industrial laboratory area. This minimizes the transfer of coal dust to the rest of the Centre. Those laboratories with the greatest dust generation in the industrial laboratory area are located on the contaminated side of the dust lock.

Located adjacent to the Pilot Plant/Industrial Laboratories wing, and separated from the rest of the Centre by a dust lock, is the **High Head Laboratory**. It accommodates pressure-related coal research and experiments being carried out by the Alberta Research Council to convert coal to higher forms of energy. Within this area, explosion-protected spaces are provided for large bench-scale, high-head experiments, as well as industrial development work. The area has 10-metre-high ceilings, and is designed to accommodate individual laboratories measuring seven metres by seven metres with moveable walls.

The two-storey **Analytical Laboratories and Office** complex houses all the administrative offices, most analytical laboratories, the library, the computer centre and drafting services.

Provision is made for real-time computer control of various processes, including fibre optic links from central computers to pilot plants.

All inlet air is filtered, and air extracted from laboratories is removed by individual extraction fans, one for each laboratory. As air is extracted through a laboratory's fume hood, a compensating supply of conditioned air at the right temperature is added to the room to maintain the air balance. This avoids the risk of fumes being drawn into the room from elsewhere in the building.

Although offices are air conditioned, the pilot plant and most laboratories are not. Instead, air is tempered by heating coils placed in air inlet ducts. These maintain laboratory air at a constant or controlled temperature year-round, regardless of the temperature extremes normally associated with Alberta's climate.

The Centre design is based on standard laboratory modules. The use of one commercial system of laboratory furniture allows laboratories to be adapted quickly and inexpensively as program requirements change.

Coal Research Organizations

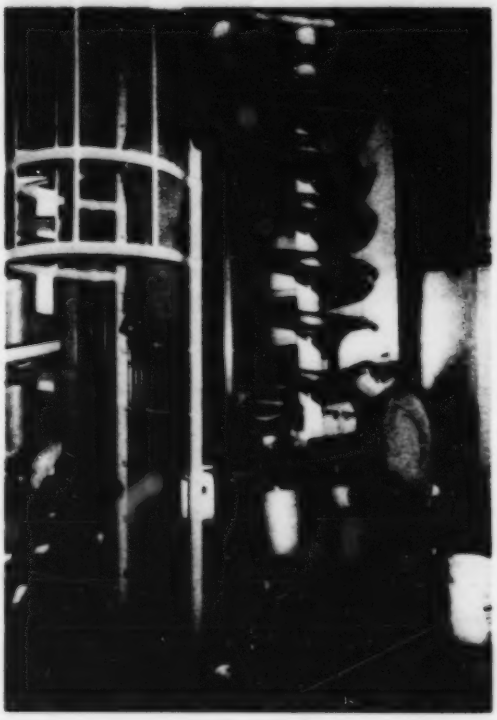
Canada Centre for Mineral and Energy Technology (CANMET)

As the main technology development branch of Energy, Mines and Resources Canada, CANMET is involved in many aspects of mineral and energy technology, including mining, mineral processing, coal mining and preparation, fuels, and metals and materials technology. It conducts a balanced in-house and contracted research and development program, providing research that is directly beneficial to industry, while also stimulating more research and development within industries.

Coal research is one of five research activities. It is carried out in Sydney, Nova Scotia; in the Ottawa area; and at the Coal Research Centre, Devon.

During the 30 years that CANMET has operated research laboratories in Alberta, the principal focus of activities has been to find new and more efficient methods of preparing coal for market. The influence of this work, especially in the treatment of coals containing large amounts of fines, can be found in coal preparation plants in Canada and several other countries.

CANMET's coal research in western Canada is carried out through ongoing studies at operating plants and by using bench-scale laboratory equipment. Also, CANMET operates a pilot plant at Devon that is unique in Canada.



Use of a spiral separator is one of many options available at CANMET's coal washing pilot plant.
(Photo courtesy of CANMET)

In addition to expertise in fine coal cleaning, some of CANMET's research efforts at Devon are aimed at solving environmental problems experienced by coal companies, especially the dewatering of tailings and the treatment of waste waters.

CANMET also has the only facilities available in Canada to fully evaluate coal for coke manufacture, and is one of the few centres in North America with extensive coke-testing capabilities.

All of these activities are the responsibility of the Fuel Processing Research Laboratory. Another division, the Surface Mining Laboratory, has interests in surface mining methods, spontaneous combustion of coal, the geotechnical aspects of surface mining, operations research and reserve assessments.

Coal Mining Research Company

The Coal Mining Research Company is a private, non-profit company established in 1977 to provide industry and government with research, development and technology transfer services related to the mining and beneficiation of coal. Although the company was financed initially by A/CERRF, its funding in recent years has been through contract research work performed for mining companies, consultants and various government agencies.

The company's programs are based on the belief that the future of Canada's coal mining industry lies in the areas of: innovative research and technology; improved operational and financial performance; new products; and the transformation of coal into a premium and reliable energy source and fuel base that can compete with other commodities in both the domestic and international markets.

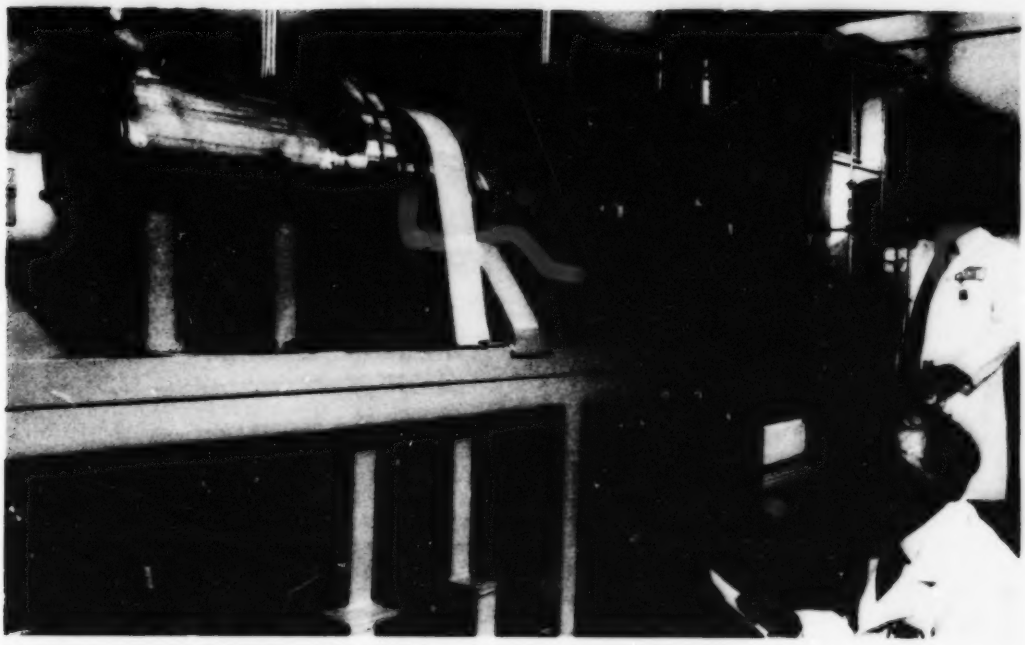
Therefore, services offered by the company cover the entire coal production spectrum, from resource to end product and from exploration to site reclamation.

The Coal Mining Research Company is involved in the application of geophysics to assist in mine planning and operations, including geology, geomechanics and coal quality determinations. Emphasis is placed on the transfer of innovative technologies relating to the development of advanced automation systems for mining equipment monitoring and control. Computer modelling for surface mining operations, geotechnical research, surface mine reclamation studies, and occupational health and safety aspects are other important areas.

Activities in coal preparation include development of improved coal cleaning processes, studies of coal drying, coal analysis and testing, and investigations of the effects of coal use on the environment. In particular, test and development work has focused on product-sized coal containing the distribution of particle sizes common to western Canadian coals. The company is also known for its work on measurements of coal handling, dustiness, susceptibility of coal to spontaneous combustion and moisture, and gas absorption/desorption characteristics.

An ASTM dustiness test cabinet (left) and a Durham cone coal flow measurement apparatus are being used by the Coal Mining Research Company in studies of new or improved methods of coal drying and handling.

(Photo by Alberta Public Affairs Bureau)



A continuous oil recovery unit was designed and built to study oil recovery during coal agglomeration.
(Photo courtesy of Alberta Research Council)

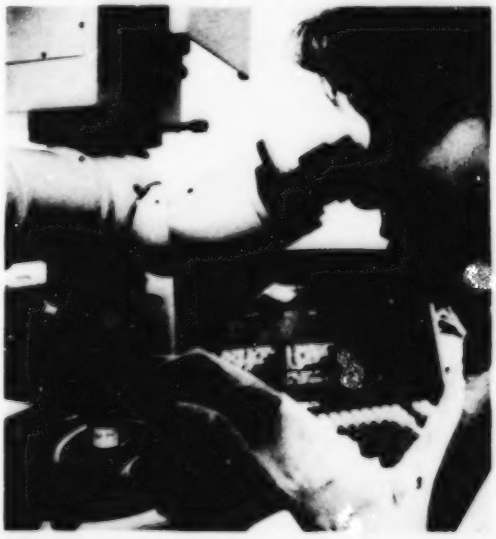
Alberta Research Council

Since it was established in 1921, the Alberta Research Council has included energy resources research among its many scientific areas of interest. It was one of the first organizations to recognize the potential for co-processing coal and heavy oil/bitumen into higher value refinery feedstocks. In recent years, the provincial Crown corporation has been actively involved in a broad range of investigations related to the hydroliquefaction of coal and upgrading of coal liquids, bitumen and heavy oil, using high-pressure and high-temperature equipment, complete with process monitoring, computer control and data acquisition systems.

Also, facilities and expertise have been developed to beneficiate bituminous and subbituminous coals by selective agglomeration with bitumen or heavy oils. A modification of the process can be used to recover oil and tar from wastes and contaminated soil.

These and other coal-related projects are supported by a broad range of laboratory services, including an established capability in petrography and special analyses such as pore volume and surface area determinations.

While much of this research effort has been supported by financial assistance from A/CERRF, the Coal and Hydrocarbon Processing Department of the Alberta Research Council provides the energy industry with a broad range of expertise and services, and staff regularly participate in technical seminars to make their non-confidential findings available to the scientific community at large.



Petrographic measurements employing optical microscopy are used to establish relationships between the maceral content of coals and their suitability for conversion to liquid or gaseous fuels.
(Photo courtesy of Alberta Research Council)

Complementary Research Activities

At the working level, representatives of all three research agencies co-operate in designing programs, acquiring equipment and assuming responsibilities for activities common to all of them.

An example of this complementary approach was the Coal Mining Research Company's decision to not duplicate coal preparation services being provided by CANMET or other organizations. Also, several components of the Centre are jointly operated by two of the tenants, while other facilities are shared among all the agencies. For example, CANMET and the Coal Mining Research Company jointly use the bulk handling facility located in the pilot plant area.

Pilot Plant Capabilities

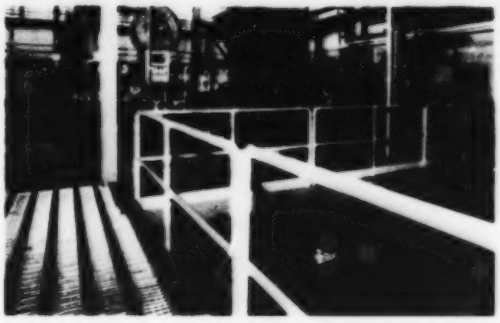
At the receiving area of the Pilot Plant, 10 or 15 tonnes of raw coal samples arrive at a time in bulk, barrels or one-tonne sacks. The coal is dumped into a coal receiving hopper and delivered by conveyor to the upper floor of the pilot plant. Here, it can undergo two types of screening processes, depending on subsequent processing requirements.

For example, the major thrust of CANMET's coal preparation research has involved wet processing of coal fines. This is because the fines content of western Canadian coal is approximately twice that of coal produced in most other parts of the world. Therefore, that fraction of incoming coal larger than 10 mm (0.4 in.) is removed by screening before it is processed in CANMET's coal washing pilot plant.

On the other hand, the Coal Mining Research Company is primarily interested in studying product-sized coal. Therefore, a twin-ring cage mill installed in the bulk handling area allows preparation of feed coal having a top size as large as 50 mm (2 in.) or as small as 3 mm (0.12 in.).

In the same area of the Centre, CANMET's coal washing pilot plant is a continuous stream, multi-component operation where processes similar to those in full-scale mine-site preparation plants can be simulated. It is capable of handling coal at a feed rate of 10 tonnes an hour. Here, coal fed at a constant rate is crushed, screened, wet-screened, slurried, and simultaneously passed through different processes. Computer control of this pilot operation allows 16 different combinations of processes to be tested, all of which are potentially applicable to western Canadian coal.

Complementing CANMET's approach, the Coal Mining Research Company operates a dry process plant of its own design where only one process stage is studied at a time. Thus, individual process components can be added or removed at will with a minimum of operators. Individual component processes, however, are operated continuously.



The one tonne an hour Roto-Louvre drier, operated by the Coal Mining Research Company, is located in the Pilot Plant, but it can be used in field demonstrations at operating coal mines.

Some of these operations involve as much as 50 tonnes of coal at a time, resulting in separation of the processed coal into numerous fractions for further examination. To accommodate this, a sizeable area has been reserved at the Centre to store several thousand sample barrels. Handling equipment is available to minimize the need for manual labour.

Also located in the pilot plant area is a control laboratory, at the junction of the pilot plant and industrial laboratory area. Here, routine coal analyses typical of an operating mine are performed for control purposes. These analyses are also used as a reference by the operators of mine-site laboratories.

A coal drying room that is used by all three research agencies is located in the pilot plant section. As much as 20 tonnes of coal at a time can be spread on the floor of this room and dried by electrical pads embedded in the floor and warm air circulated above. This allows moisture contents to be reduced to one or two per cent, as required by various sampling and analysis procedures.

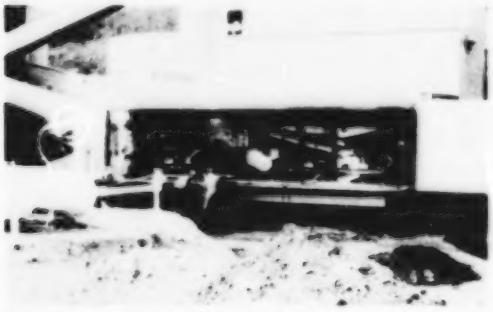
A coal sample preparation room, jointly designed and operated by CANMET and the Coal Mining Research Company, is used to segregate coal samples into various sized fractions.

Based at the Centre are three trailer-mounted mobile pilot plants. These are used by CANMET at mine sites to perform field demonstrations of coal dewatering equipment and methods of improving the quality of waste waters. These demonstrations are done without interrupting normal mine operations.

Coal drying experiments comprise a major research program at the Coal Mining Research Company. Coal is dried with a 150 mm x 150 mm (6 in. x 6 in.) fluidized bed dryer, which handles batches of fine

coal up to 20 kg (44 lb.) in weight, and a one tonne an hour continuous Roto-Louvre drier. The latter can handle normal, product-sized coal having a top size of 50 mm (2 in.). The Roto-Louvre unit, having a moisture evaporation capacity of 0.2 tonnes an hour, is ideal for research because it can dry virtually any type and size of particulate material and enables a variety of commercial-scale, continuous drying conditions to be simulated in the Centre pilot plant or in field demonstrations. This drying service, coupled with the dry process research carried out by the Coal Mining Research Company, represents a capability that exists nowhere else in Canada.

Comprehensive carbonization testing is carried out by CANMET to study the conversion of western Canadian coals to the coke used for steel making. This service is of considerable value to the coal industry. The test program includes studying the carbonization characteristics of coals that have been treated with additives or washed in a particular manner.



CANMET's trailer-mounted pilot plants (one of which is shown here) are used at coal mines to demonstrate coal dewatering equipment and methods of improving waste water quality.

(Photo courtesy of CANMET)

Industrial Laboratory Activities

Various field exploration, mining and processing projects are administered at the Centre. The shops and laboratories located throughout the Centre, as well as the facility's computing services, are designed to provide specialist support capability to mine-site projects.

Within the industrial laboratory area, the Coal Mining Research Company operates a drying development lab to support its coal drying and dry process research. Here, the moisture characteristics of coal from British Columbia, Alberta and Saskatchewan are measured. In this laboratory, analytical methods are being developed for product-sized coal and upgraded coal products, as opposed to the common test methods that can be used only on coal that has been crushed and ground to a small particle size. Also in this laboratory, proprietary work has been done on the absorption and desorption of certain gases by coal to prevent it from reacting with atmospheric oxygen.

An INSTRON triaxial test apparatus, operated by the Coal Mining Research Company, is used to measure the strength properties of rock and coal.

(Photo by Alberta Public Affairs Bureau)

During the Centre's early planning stages, it was decided that responsibility for float and sink analyses would be divided between CANMET and the Coal Mining Research Company. Consequently, fine coal float and sink analyses are carried out by CANMET in the industrial laboratory areas, while the Coal Mining Research Company conducts coarse coal float and sink analyses in the pilot plant area. The latter laboratory is equipped with a nine-position bench to efficiently handle the large samples necessary for coarse coal characterization and pilot-scale or full-scale plant performance tests.

Also located in the industrial laboratory area is a rock mechanics laboratory operated by the Coal Mining Research Company. It houses a 450 000 kg (one million pound) INSTRON triaxial test apparatus, the largest machine of its kind in Canada. This computerized equipment measures the strength properties of rock and coal used in evaluating the designs of mines.

High Head Laboratory Activities

The high head laboratory is the site of numerous experiments carried out by the Coal and Hydrocarbon Processing Department of the Alberta Research Council for government and industry clients. Coal studies are performed using facilities that range from microscale, atmospheric-pressure batch equipment to high-pressure, continuous systems capable of establishing concepts and reaction conditions for pilot-scale or larger-scale coal conversion operations.

In this laboratory, researchers are exploring various methods of producing liquid or gaseous hydrocarbons from coal, and have developed the necessary analytical techniques to characterize the reaction products. Here, co-processing of coal and bitumen or heavy oil has been studied for several years, as has coal liquefaction under various operating conditions, some of which are less severe than those commonly used in processes being developed in other countries. A capability is also being established to gasify coal and characterize the products in response to a renewed interest in gasification as a clean fuel technology.

Coal combustion work is also carried out here using entrained-flow and single-particle combustors, as well as thermogravimetric analysis. This research determines the relative combustion characteristics of various coals and the effect of upgrading treatments on combustion properties.

The high head laboratory is also the site of coal agglomeration studies aimed at upgrading Alberta coals. This work has progressed to a six-tonne a day continuous pilot plant operation.

In the High Head Laboratory, coal liquefaction and coal/bitumen co-processing have been studied for several years.

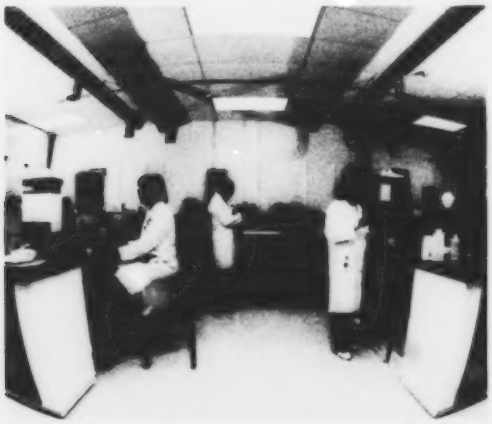
(Photo courtesy of Alberta Research Council)

An entrained-flow combustor (left) and a thermogravimetric analyser (right) are used in Alberta Research Council studies to gain a better understanding of the combustion characteristics of Alberta coals.

(Photo by Alberta Public Affairs Bureau)

Analytical Laboratories

The Centre's analytical laboratories provide a broad range of services that are available to all three agencies. Included are such techniques as gas, liquid and ion chromatography, and fine particle analysis. These laboratories are capable of providing virtually every type of analytical service required to support current and future research projects. They represent some of the most extensive analytical capabilities of their kind anywhere.



Elemental Analysis Laboratory.
(Photo courtesy of Alberta Research Council)

Future

Now that all three coal research groups are located within one facility, the Alberta Office of Coal Research and Technology is working to establish an even closer integration of their coal research objectives and programs.

Contacts

For more information about the research programs and services offered by each of the three agencies located at the Coal Research Centre, Devon, contact:

Dr. T. David Brown
Director of Coal Research Laboratories
CANMET
P.O. Bag 1280
Devon, Alberta
T0C 1E0
Telephone: (403) 987-8270

Dr. Arvid Hardin
Director
Coal and Hydrocarbon Research Department
Alberta Research Council
P.O. Bag 1310
Devon, Alberta
T0C 1E0
Telephone: (403) 987-8118

Mr. Ray Chopiuk
President
Coal Mining Research Company
P.O. Bag 1400
Devon, Alberta
T0C 1E0
Telephone: (403) 987-8195

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Information Centre
Alberta Energy/Forestry,
Lands and Wildlife
Main Floor, Bramalea Bldg.
9920 - 108 Street
Edmonton, Alberta
T5K 2M4

Telephone: (403) 427-3590

For more information about A/CERRF, contact:

Senior Manager,
Technology Development
Scientific and Engineering Services and
Research Division
Alberta Energy
2nd Floor, Pacific Plaza
10909 Jasper Avenue
Edmonton, Alberta
T5J 3M8

Telephone: (403) 427-8042

Telex: 037-3676

More can be learned about the Alberta Office of Coal Research and Technology by contacting:

Chairman
Alberta Office of Coal Research and Technology
Alberta Energy
2nd Floor, Pacific Plaza
10909 Jasper Avenue
Edmonton, Alberta
T5J 3M8

Telephone: (403) 427-8042

Telex: 037-3676